The American Fertilizer

Vol. 99 DECEMBER 4, 1943 No. 12

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See page 25

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AMERICAN FERTILIZER

"That man is a benefactor to his race who makes two blades of grass to grow where but one grew before."

Vol. 99 DECEMBER 4, 1943 No. 12

The Maintenance of Soil Fertility

By E. M. CROWTHER, D.Sc, F. I. C.

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THE numerous recent programs of post-war agriculture generally begin by stating that there must be a well-balanced and prosperous future for the agricultural industry, that agricultural land must produce its maximum and that its fertility must be safeguarded. It is proposed to examine a few aspects of the last point. The problems involved extend far beyond the single one of maintaining the soil organic matter, important though that may be, and they are not to be solved by endowing the word "humus" with magical properties.

There is no short-cut to maintaining soil fertility. One may borrow from the Atlantic Charter the phrase "Freedom from Want," and then remember that crops have many needs and that soils differ greatly in their resources. They may lack air or water, and be deficient in lime or in one or more of several plant nutrients. The principal needs of crops and the diversity of soils are well illustrated by experiments on continuous cropping. In the continuous wheat field at Rothamsted plots with sulphate of ammonia and other inorganic fertilizers have continued for a hundred years to give as good yields as those with farmyard manure, and even the completely unmanured plot has maintained about the same yield as the world average. When the experiment was repeated on light land at Woburn the yields on the sulphate of ammonia plots collapsed after about twenty years, but the soils were restored to fertility by liming.

If agriculture is to produce enough for a rapidly rising standard of living throughout the world, it must keep pace with technical developments in other industries. It is no solution to advocate returning to the slower tempo of past centuries. New forms of mechanical power and schemes of irrigation or drainage make it possible to raise the fertility of vast areas of poor land. In U. S. S. R. the cultivation of the drier steppes had to await the introduction of tractors. In this country we have had many recent examples of land reclamation depending on track-laying tractors and modern drainage machinery.

All new techniques have their dangers, and careful investigations will be needed if we are to avoid repeating some past mistakes. The major tragedies in agriculture occurred when traditional systems were transplanted to radically different environments, or when they were hurriedly transformed by the introduction of alien crops, implements, or economic systems. Governments are now realizing their responsibilities for safeguarding the land and for studying the technical problems involved.

The fertility of the soil is not a wasting asset like the reserves of a coal- or oil-field, and few systems of farming are bad enough to be described as "mining the soil." The essential properties of the soil depend on the way in which the parent rock material has been modified by the combined action of weather, micro-organisms, plants, animals and man. The top few inches of soil are the most important. They may have taken thousands of years to form, but they may be lost or seriously damaged in a few years. The subsoil is normally much less fertile, and it may be so raw that only small quantities can safely be brought to the surface at a time. Under favorable conditions it acts as a useful reservoir for water, and its supply of available nutrients, though small, may be tapped and

restored to the surface by deeply rooting plants. On the other hand, heavy subsoils often impede drainage.

Some of the principal factors in maintaining soil fertility may be brought out by considering those involved in the formation or degradation of a few of the main world groups of soils.

Soil Formation and Conservation

It is convenient to begin with soils built up under forests. In cold, wet regions the floor of the coniferous forest is covered by a carpet of peaty litter, which decomposes very slowly. The mineral soil is leached of bases and nutrients and the soil colloids break down and segregate, leaving a bleached and exhausted horizon over one stained or cemented with oxides of iron and aluminum. This gives the Podzol soil, which also occurs on many of our heaths and moors. Drainage, deep cultivation and liming are needed to fit it for agriculture.

Under the broad-leaved forests of the moist, temperate zone the abundant leaf-fall and ground vegetation enrich the surface soil with organic matter and with plant nutrients brought up from a considerable depth. Little soluble material is lost and the mineral colloids remain stable. Earthworms distribute organic matter throughout a great depth. The surface soil develops a good crumb structure, capable of absorbing the whole of the rainfall.

The luxuriance of the high primeval forest of the wet tropics led all new-comers to believe that the soils must be highly fertile. Actually they are intrinsically poor, but the available capital of plant nutrients circulates very rapidly and little is lost. The small supplies brought up by the big trees from great depths are concentrated in a thin layer of surface soil, which is often separated sharply from very poor acid subsoil. The surface soil is protected by the dense plant cover and constantly receives fresh organic matter which decomposes rapidly. When this type of forest is cleared from plantations, the whole of the rich film of surface soil with its store of fertility may be lost in a few years. This happened with dreadful regularity in the early days of rubber, tea and coffee plantations in Africa and the East, especially where European or Chinese methods of clean-weeding were introduced. The exposed raw subsoil was incapable of absorbing the torrential rains, and erosion soon set in. Terracing, silt-pitting, contour-planting, cover cropping, selective weeding and even a so-called "forestry system" had to be improvised to save what was left and to try to make some new soil.

Totally different soils are formed where grass is dominant and seasonal droughts prevent tree growth. Where hot, dry summers are followed by very cold winters, moisture from the melting snow allows a rapid growth of coarse grass in spring and early summer. The soil receives large quantities of organic matter, which decomposes slowly as the soil is either very dry or very cold for the rest of the year. The plant roots and the accumulating organic matter build up a highly granular soil structure, admirably fitted for the continuous cultivation of cereals and other drought-resisting crops. This is the famous Chernozem or Black Earth, which is seen to perfection in the Ukraine. With lower rainfall and higher temperatures the vegetation is less luxuriant, the soils have less organic matter and crop residues decompose rapidly. The Southern Chernozem and the Chestnut soils to the South and East of the Ukraine have been brought into cultivation by mechanization only during the last twenty years. They will not stand continuous cereals and the authorities are trying to work out rotations with restorative crops. Under somewhat similar conditions in the prairies of the United States and Canada excessive cultivation by dry-farming methods led during a run of drought years to the Dust Bowl. The general remedy is to restore the balance between constructive and destructive soil processes by contour-ploughing, strip-farming and cover crops, which anchor the soil, protect it from wind and rain, add organic matter and nutrients, and rebuild the crumb structure.

At still higher temperatures in the Tropics permanent farming in the "grass" and "low bush" zones is even more difficult. In Africa there is the further complication that the soils were heavily leached and eroded during the Pleistocene period, when much of Northern Europe and America had the parent material of its soils renewed as glacial drift and loess. Before European intervention the African farmer maintained a low level of subsistence agriculture by "shifting cultivation." His gardens were untidily cultivated by the hoe into hills or ridges, and he generally mixed his crops. These practices protected the soil from wash and intense desiccation. The introduction of cotton and other cash crops led to more intensive cultivation, which often extended dangerously on to steep slopes. Sometimes the use of the plough and clean cultivation had disastrous results. Some demonstration farms were eroded away in a few years to leave only the underlying ironstone platform.

The fundamental problem in Africa is to

intensify agriculture without endangering the soil. Attempts are being made to introduce European methods of mixed farming, but there is still the danger that the farmer may expose too much land, unless he can be taught from the start to plough along contours and use a safe rotation. Promising results have been obtained in Uganda experiments by planting elephant grass for a few years in rotation with cotton and food crops. Other methods will have to be devised for using the bush to regenerate the soil. In the wetter parts composts can be made from forest undergrowth.

Within the major world groups of soil there are innumerable local varieties, determined mainly by the geological nature of the parent material, the drainage conditions and the stage of soil formation or degradation. Well-defined soil series can be recognized and mapped by soil surveyors. When a soil survey is well advanced the soil series becomes the basis for interpreting and correlating agricultural experience and the results of experiments, and methods developed for one area can speedily be applied to similar soils elsewhere. Wartime experience has revealed many technical problems which must be treated on a regional or national basis and are best approached through the soil survey. For post-war planning we need reliable information about the actual properties and potentialities of our soils and not merely a record of their current use. As we push on with surveys around towns and industrial areas ripe for development, we must not overlook the fundamental value of the general soil survey, which in this country is still on too modest a scale.

Crop Rotations in Great Britain

Our temperate climate, free from torrential rain and prolonged drought, spares us the more dramatic forms of soil erosion, but recent blowing of light fens and sands in Eastern England raises doubts as to whether some of this land is not over-cultivated. Untilled land develops its own protective cover of grass, scrub and forest all too rapidly, and the farmer's main struggle has always been to cultivate sufficiently well to keep down weeds or to manage his grazing so as to prevent the re-invasion of rushes, bracken or scrub. By long experience, methods were developed for balancing the constructive and destructive soil processes by a system of rotations, which until recently were enforced by contracts, custom and taboo. On these short-term rotations there was superimposed a similar long-term cycle of more intensive arable farming in times of prosperity and resting under grass in periods of depression.

The earliest rotations were either two-field or three-field: corn, wild grass or winter corn, spring corn, fallow. It must be remembered that for most of the fallow year the soil was left uncultivated and covered itself with grass and weeds, which were grazed. Later a root break was introduced and natural weeds and grasses were replaced by "artificial grasses," including clovers. (In parenthesis one may express the hope that as we have dropped the adjective "artificial" from grasses and clovers after two centuries of experience, we may also drop it from fertilizers after more than a century.)

The Norfolk rotation fitted in admirably with the winter feeding of bullocks, especially when concentrates were imported in large quantities. Farmyard manure acquired a new importance, and, as our towns expanded in the Industrial Revolution, it was supplemented by stable manure brought back in the carts which took food and fodder to the towns. A hundred years ago four loads of manure were collected every day from Regent Street alone. Later the railways took this stable manure farther afield to build up the market gardening soils of Biggleswade and North Kent, which are now suffering from its disappearance.

On the lighter soils, other rotations were developed with a succession of green crops and roots folded off by sheep alternating with cereals, which were often undersown with trefoil. Although there has been no detailed analysis it appears that the effects are two-fold. The actual puddling gave a temporary structure to the soil, and the potash brought up by the green crops was returned in urine to the surface soil in sufficient amounts to provide for one or two cereal crops. As sheep folding declined, much of this land reverted to indifferent grass and, when this was ploughed up during the war, the cereals often suffered from acute deficiency of potash, especially on soils derived from the Upper Chalk.

In the cooler, wetter regions the rotation was lengthened to allow several years under grazed ley, but often the grass was left down indefinitely and given little attention. A mat of undecomposed turf formed on the surface and the land became acutely deficient in lime and phosphate.

The work of Sir George Stapledon has shown how the modern resources of plant breeding, machinery and fertilizers can be used to fit suitable leys into a wide range of conditions of soil, climate and farming systems. It is now becoming possible to

establish a balanced and safe agriculture at a high level of productivity.

So far there have been very few field experiments in Great Britain on the effects of different rotations on soil fertility. A useful beginning has been made at Woburn, where the effects of three years under grazed seeds or lucerne and three years under tillage crops, with and without a one-year ley for hay, are tested on potatoes followed by barley. In the first test year, potatoes without dung after the three-year leys were as good as those with dung after the arable crops; the benefits from the leys were even greater on the following barley. Experiments on rotation must of necessity be planned on a long-term basis, and it is highly desirable that Colleges and Farm Institutes should use their security of tenure to undertake such experiments, which are unsuitable for commercial farms.

The need for such experiments will, perhaps, be more widely appreciated when attempts are made to find a sound basis for assessing the value of stored-up fertility as a "productive" and therefore untaxed asset for income-tax purposes.

Plant Nutrients in Soils

Our knowledge of animal and human nutrition made slow progress until foods could be analyzed into nutrients; first, into carbohydrates, fats and proteins, and, later, into individual amino-acids, carotene and the rest of the vitamins, calcium and other mineral elements. Similarly in crop nutrition, the recognition of the effects of simple nitrogen compounds and ash constituents provided a scientific basis for manuring and for maintaining soil fertility.

The first broad generalization—Liebig's Law of Minimum—went too far, as most sweeping statements do, but it is a good first approximation and is still sadly neglected. It stated that the growth of crops depends primarily on the nutrient in shortest supply. If one factor is seriously limiting, complete manures or compound fertilizers may be wasteful. It would be better economy to reserve the complete manures for soils in good heart until the main deficiency on the less fertile soil has been made good.

A few of the commonest causes of infertility may be briefly reviewed. There can be no doubt that the principal one throughout Great Britain is shortage of lime or, what comes to the same thing, soil acidity. Drainage water necessarily carries away lime, mainly as calcium bicarbonate. The loss is greatest in the wettest regions or where the rain is acidified by sulphuric acid from coal fires and industrial plants. It becomes serious most rapidly on light soils or on those derived from rocks with low base contents. The great increase in liming under the Subsidy Scheme has only touched the fringe of the problem, and an appreciable fraction of the extra lime has been used to build up further reserves on soils already well stocked. Few new developments will do more to improve the fertility of our soils than the general use of relatively coarsely ground limestone on acid soils. The rock occurs within short distances of almost all our farms; it is cheap to produce and easy to apply, but the grinding plants and the popular demand are still lacking.

The second nutrient liable to serious loss by drainage is nitrogen in the form of nitrate. Losses are high with cereals. The young plants are unable to take up much of the nitrate formed in autumn and the bulk is washed out in winter; cereals make their heaviest demand in the spring before the soil has warmed up sufficiently for active nitrification; more nitrate is produced after harvest and lost in the following winter. The losses in nitrogen through the soil are more serious than the actual removal in the crops. It is largely for this reason that in most rotations cereals follow dunged roots or leys in which leguminous crops have fixed atmospheric nitrogen and left reserves of nitrifiable organic matter. Second or third corn crops are particularly liable to be short of nitrogen. Much of the success of the food production campaign has been due to the greatly increased use of nitrogenous fertilizers, especially for cereals.

Contrary to common belief there is no justification for cutting down the nitrogenous dressings merely because a crop has been dunged. Dung improves the physical conditions and supplies many nutrients which allow the crop to respond to further dressings of inorganic nitrogen. In some quarters there is still a prejudice against nitrogenous fertilizers because they are alleged to exhaust the soil. Certainly bigger crops take more out of the land, but few farmers object to good weather, good seeds, and good cultivation because they, too, give bigger crops. In wartime it is justifiable to mobilize soil reserves; the lime, phosphate and, to a more limited extent, the potash can be put back as fertilizers during the war and the reserves can be built up again afterwards.

Phosphates are not subject to loss by drainage, but they become unavailable in other ways. The soil is a poor storehouse for phosphates; from 70 to 90 per cent of the amounts added in manures and fertilizers fail to reach

(Continued on page 20)

Axis Loses Sicily and Sulphur

By VIRGINIA KINNARD

Bureau of Foreign and Domestic Commerce

ITALY ranks as the world's second largest producer of sulphur, being surpassed only by the United States. The island of Sicily in normal times accounts for almost three-fourths of the total Italian output and approximately one-tenth of the entire world production.

The Italian Industry

During the fiscal year 1938–39, Italy produced 355,007 metric tons of sulphur. Of this amount, 64 per cent, or 227,688 tons, came from Sicily; the Italian mainland output was 127,321 tons.

While Sicily boasts 100 sulphur mines, continental Italy possesses but six, located in Ancona, Pesaro, and Forli.

From these mines in 1938, Italy (including Sicily) exported 227,395 metric tons of sulphur, a product which has been that country's principal non-metallic mineral export item for many decades.

Sulphur producers in Italy and Sicily have faced difficult problems in labor, transportation, and raw materials. The German shortage of railway cars has been particularly serious to both members of the Axis. The Ente Zolfo Italiano (Italian Sulphur Organization) set up by a decree of April 2, 1940, replaced the former Office for the Sale of Italian Sulphur. A permanent body, it is administered by a Council composed of a president and ten other members nominated jointly by the Ministers of Corporations and Finance.

The production-quota system previously in force was abolished under the new decree, but the guaranteed minimum price was maintained. Prices have been fixed annually by the Ministers of Corporations and Finance in June of each year. The organization has had power to control the development of the sulphur industry, and during the past few years has exercised this authority for the benefit of the war machine.

The Nazi Reich has had access to these large supplies of Italian sulphur. Germany imported 103,600 metric tons of sulphur in 1938 (the last year for which complete statistics are available). German foreign-trade statistics for the first seven months of 1939 indicated imports of 34,933 metric tons of sulphur, of which 31,924 came from Italy. It is thought, however, that imports since the beginning of the war have been much greater. Sicilian sulphur mines reportedly have been working at production capacity—at least 350,000 tons—to meet the demand from Germany. France and the United Kingdom were the large importers of Italian sulphur in *pre-war* years.

Position of United States

But, before hostilities began in Europe the United States, too, profited from trade in sulphur; Germany purchasing from this country 47,349 tons, valued at $874,721, in 1937. Coincident with the growth and development of its synthetic industries, Germany bought somewhat less from us in the succeeding year—32,817 tons, or $610,750. Exports dropped sharply in 1939, and only a quarter as much was sent to the Reich in the year of Poland's invasion. But the 8,702 tons which sold for $148,409 in 1939 were followed by an absolute dearth of supplies from the United States in 1940 and to date. As could be expected, the United States does not sell sulphur to Italy, but that is about the only major country which does not buy some from us in the ordinary course of commerce.

Japan, Spain, Other Producers

Japan, ranking third in world production of sulphur, produced from 150,000 to 200,000 tons annually before the war, an amount sufficient only for Nippon's own needs. None could be spared to Germany even if it were possible to ship it. Japanese output was reported at 175,323 metric tons in 1936.

Spain mines sulphur, too—about 25,000 tons annually; this, with Turkey's output (approximately 3,000 tons) about exhausts the list of significant European sources of the natural material.

Some sulphur is obtained in South America, Chilean output being the largest. Throughout the rest of the world, with the exception of the United States, production is negligible.

With control of Sicily now wrested from the Axis, Germany will be unable to depend on supplies of sulphur from any other country in quantities sufficient to be of real use

and will be forced to rely on accumulated stocks or current manufacture.

German Efforts, Difficulties

There is no direct German sulphur output; the chemical is obtained either from mineral ores or as a by-product in industrial processes. Native sulphur, in amounts to justify working, has not been found in Germany. Before the war, the great bulk of the German sulphuric-acid production was manufactured from pyrites. The remainder was obtained in the processing of zinc and copper ores and to some extent from coal. Only a small part of Germany's requirements of pyrites can be met from its own resources, although domestic mining was intensified in an attempt to overcome the national shortage caused by the curtailment of imports.

The Allied naval blockade has had a serious effect upon Germany's imports of pyrites. Spain, the world's leading producer, *was* the principal source, normally furnishing the bulk of the German supply, so interruption of imports by sea intensified the existing shortage of sulphuric acid in Germany. In addition, Spanish pyrite production, slowed down markedly during the civil war, has also been affected by conditions incident to World War II. This situation has been a serious blow to the acid industry in Germany, since consumption of pyrites there reached approximately 1,000,000 tons annually. The shortage of sulphuric acid was apparent even before the war as a result of the small amounts of foreign exchange available in Germany to pay for imported pyrites.

Imports of pyrites were also obtained from Norway, Cyprus, Italy, and other countries. Although Norwegian pyrite resources, now under German control, partly offset losses in supplies from overseas, particularly from Spain, the shipping problem is by no means a small one. Some pyrites are available in other occupied countries—Czechoslovakia and Poland, for example—but not in quantities sufficient to keep pace with a growing demand occasioned by the pressure of war on two or more areas.

Varied Sources Utilized

Germany was making definite progress in pre-war years in developing new processes for the recovery of sulphur from coke-oven gas and from synthetic motor-fuel production. Large and increasing amounts of sulphuric acid were being obtained from coke and hydrogenation plants. Accordingly, the expanding German output of sulphur derived from these methods made serious inroads on the market for Italian sulphur and brought some concern to the sulphur-mining industry in Italy.

However, in the period immediately preceding the war, although these by-product methods made rapid strides, the demand increased even more rapidly. Consumption was still ahead of the progressively expanding domestic output of sulphuric acid from pyrites, cokery gas, and other sources. It was necessary to obtain the raw material for acid production from every possible source because of the phenomenal growth of fertilizer, synthetic-fiber, and other large basic industries. World War II naturally brought a huge additional need for sulphuric acid for military purposes—the demands of munitions factories are unremitting.

In addition to sulphur obtained from coke-oven gas, Germany has a production source in water-gas, in the synthesis gases of the large synthetic-gasoline plants, and from zinc blends. Recourse has probably been taken to other more or less unsatisfactory methods of offsetting the lack of sulphur. Coke-oven production of sulphuric acid was principally in the Ruhr district, where the cokery industry has been concentrated and where it has undoubtedly been slowed up by Allied bombing.

War's Exigent Demands

One method attempted in Germany during World War I was the uneconomic processing of gypsum. It was discarded after the armistice but was reintroduced in 1937 at I. G. Farbenindustrie's Wolfen plant, which is reported to have been making 80,000 tons of sulphuric acid annually by a process developed at Leverkusen. The recovery of sulphuric acid and carbon bisulphide from synthetic fiber production also has probably furnished some material.

Sulphuric-acid production in Germany in 1939 was about 2,800,000 metric tons, having almost tripled during the five-year period since 1934, when the total was only 1,066,700 tons. To the almost 3,000,000 metric tons must be added a war demand which probably doubles the pre-war, despite curtailments in the less essential industries. It is known that efforts have been made for several years to economize in the use of acid whenever possible and to increase the output from all sources. Additional processes have been employed for the recovery and re-use of acid, and methods of industrial production were attempted which cut down on the amount necessary. However, even with maximum use of all production facilities, Germany has

(Continued on page 20)

Increase in Phosphate Rock Ceilings

PRODUCER prices for Tennessee phosphate rock have been increased approximately 20 cents per ton to compensate mine operators for wage raises recently granted to their employees, the Office of Price Administration announced on November 29th.

These wage increases so seriously reduced the small margin upon which owners operate that continued production was threatened. The increase in maximum prices will affect sales by operators to manufacturers. This increase will be absorbed by manufacturers and hence will not affect prices paid by the ultimate consumer.

Tennessee phosphate rock is used in the manufacture of fertilizers, chemicals and munitions; hence it is essential to the war effort.

The present action followed hardship evidence submitted to OPA by companies for whose employees the War Labor Board recently approved wage increases retroactive to December 1, 1942. These companies mine and process 90 per cent of the Tennessee phosphate rock sold. Half of them, under existing price ceilings, had to operate at a loss during the year ending June 30, 1943, and faced suspension of production. The others were compelled to function on so limited a margin that they were unable to absorb the wage increase and still show a profit.

The new schedule covers all grades and descriptions of Tennessee phosphate rock.

The new prices are as follows:

Phosphate Rock

Maximum Price Regulation No. 240 is amended in the following respects:

Section 1367.114 is amended to read as follows:

Section 1367.114 *Appendix B: Maximum prices for Tennessee brown phosphate rock.* The miner may charge any person for Tennessee brown phosphate rock upon the terms and conditions, and for the grades and descriptions, the prices, all as set forth in the following schedule:

A. Unground phosphate rock:

Size—Run of mine in carload lots—washed, dried and unground.

Price—Basis gross ton (2240 pounds) f. o. b. cars at mines.

Quality—Bone phosphate of lime (B. P. L.) on a dry basis, combined oxide of iron and alumina (I. & A. determined separately on a dry basis) adjusted basis 2 units B. P. L. for 1 unit I. and A., and not more than 3 per cent moisture.

Grades—68/66 per cent B. P. L. 6 per cent I. & A. $4.50 basis 68 per cent B. P. L., 12½ cents per unit rise to 70 per cent maximum and 15 cents per unit fall to 66 per cent minimum, fractions in proportion; I. & A. basis 6 per cent with 2 units B. P. L. for 1 unit I. & A., fractions in proportion, added when below or deducted when above.

70/68 per cent B. P. L. 5½ per cent I. & A. $5.00 basis 70 per cent B. P. L., 15 cents per unit rise to 72 per cent maximum and 20 cents per unit fall to 68 per cent minimum, fractions in proportion; I. & A. basis 5½ per cent with 2 units B. P. L. for 1 unit I. & A., fractions in proportion, added when below or deducted when above.

72/70 per cent B. P. L. 5½ per cent I. & A. $5.50 basis 72 per cent B. P. L., 20 cents per unit rise to 75 per cent maximum and 25 cents per unit fall to 70 per cent minimum, fractions in proportion; I. & A. basis 5½ per cent with 2 units B. P. L. for 1 unit I. & A., fractions in proportion, added when below or deducted when above.

Lump rock—Add 50 cents per gross ton for screened lump rock of not more than 8 per cent moisture, and with no adjustment for I. & A.

Wet rock—Deduct 50 cents per gross ton for wet rock not dried.

Calcining—Add $1.00 per gross ton for calcining basis 1500° Fahrenheit plus 5 cents per gross ton for each even 100° Fahrenheit above 1500° or less 5 cents per gross ton for each 100° below 1500° guaranteed.

Grinding—Add 50 cents per gross ton for grinding 48 to 52 per cent minus 200 mesh. Add 70 cents per gross ton for grinding 58 to 62 per cent minus 200 mesh.

Car door boards—Add $2.00 per car for boarding up car doors.

Lining cars—Add 75 cents per car for paper lining doors. Add $1.75 per car for paper lining car.

B. Finely ground phosphate rock:

Price—Basis net ton (2,000 pounds) f. o. b. cars at mines in car load lots in bulk.

Quality—Phosphorous pentoxide (P_2O_5) on a dry basis minimum grade guaranteed and

(Continued on page 18)

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Principal Articles in This Issue

Report on Chilean Nitrate

In the war years 1941–42 and 1942–43, about 1,600,000 tons of Chilean nitrate of soda were brought into the United States, with a loss by enemy action of only two cargoes, totaling 12,000 tons, according to a report recently published by the Chilean Nitrate Sales Corporation. This is the largest amount imported for many years.

The report states that, whereas, in the first World War, Chilean nitrate was used largely in the manufacture of munitions, in this war the great bulk of the supply has been devoted to its most natural and valuable use, the production of food and feed. For the current year ending June 30, 1944, negotiations have been concluded for the purchase of 700,000 tons of Chilean nitrate, with a 60-day option for the purchase of an additional 300,000 tons.

Pointing out that the nitrate industry in Chile is a large buyer of American products, J. A. Woods, President of the Corporation, states that it spent an average of over $350,000 a month in the United States during these two years for its essential supplies, such as machinery, spare parts and raw materials.

Approximately 75 per cent of the world's iodine comes as a by-product from Chilean nitrate, and Mr. Woods states:

"Since the present war started, and particularly since the attack on Pearl Harbor, demand for iodine has increased considerably. In the year 1942-43 as compared with 1937–38, the Corporation's deliveries in this country increased 165 per cent. Stocks in the United States, which normally are adequate for 12 months' requirements, have been greatly enlarged, and no difficulty has been experienced in maintaining them. In consequence, no shortage of iodine has been experienced either for military or civilian uses."

In Mr. Woods' opinion, what the Government will do with its war plants after the war is of critical importance to the American free enterprise system, and also to the Chilean nitrate industry. He said:

"When the United States entered the war, this country was short of nitrogen for munitions. The Government has constructed several large plants to supply nitrogen for war purposes and production from these sources is now considerably above war requirements. No such supply of nitrogen will be needed in peace time, however.

"If the Government should use these plants to produce nitrogen fertilizer after the war, Chilean nitrate probably could not compete

with them, since no enterprise can compete with the Government. Such a development would deprive the American farmer of the natural nitrate of soda which he knows and has confidence in. It could cause widespread unemployment in Chile and by reducing Chile's purchasing power, it would largely close the Chilean market to American goods."

Fertilizer Bag Appeal Procedure

Fertilizer manufacturers, who are experiencing difficulty in obtaining bags for packaging their products, may file appeals with the Containers Division of the War Production Board for new burlap materials for this purpose.

Persons or companies so affected must file three copies of WPB Form 2907 (PD-188c), the appeal from which is required in order to present the case to the WPB Appeals Board. Consideration will be given to appeals only where every effort has been made to obtain less critical packaging materials, such as cotton or paper, and the applicant has proven he has been unsuccessful in his efforts to obtain the less critical materials.

All appeals should be addressed to the WPB Administrator of M-221, Room 2216, Temporary Building S, Washington (25), D. C.

October Sulphate of Ammonia

There was practically no change in the output of by-product sulphate of ammonia during October, the figures of the U. S. Bureau of Mines showing 65,321 tons of sulphate and 2915 tons (NH_3 content) of ammonia liquor. Shipments during the month decreased to 58,401 tons, and as a result the stocks on hand at the end of October increased to 44,957 tons.

	Sulphate of Ammonia Tons	Ammonia Liquor Tons NH_3
Production		
October, 1943	65,321	2,915
September, 1943	65,073	2,802
October, 1942	64,901	2,990
January-October, 1943	635,563	28,448
January-October, 1942	640,086	28,159
Sales		
October, 1943	58,401	3,092
September, 1943	69,107	2,988
October, 1942	63,802	3,035
Stocks on hand		
October 31, 1943	44,957	983
September 30, 1943	38,192	1,015
October 31, 1942	55,447	1,016
September 30, 1942	54,623	858

Pricing Fertilizers with Special Ingredients

OPA advises that, if a fertilizer manufacturer, consistently with Second Revised MPR-135, lists for any grade a price which, because of the inclusion of a special ingredient, is higher than the maximum price for fertilizer of the corresponding "regular" grade, he should explain to OPA, in filing his price schedule, just how he computed the higher price. For example: Suppose that the maximum price for 4–7–5, regular grade, in a certain area is $33.00 per ton. If a manufacturer's price schedule, consistently with the regulation, lists a higher price for a 4–7–5 because a quantity of copper sulphate has been added, he should give to OPA, in filing his price schedule, detailed information as to how much copper sulphate was added to each ton.

Premium Brands

OPA has suggested that in filing copies of price schedules with OPA, as required by Section 6 (b) (1) of Second Revised MPR-135, fertilizer manufacturers accompany the schedule with a statement of any price differential on any "Premium Brand," in order to confirm such differential.

For example: Suppose that the maximum price of a 3–12–6, regular grade, in a certain area is now $32.20 per ton, and that a manufacturer, during the period February 16–20, 1942, listed a 3–12–6, premium brand, at a premium of $1.50 per ton over his then effective price for 3–12–6, regular grade. If the manufacturer now wishes to charge $33.70 per ton for his 3–12–6, premium brand, he may do so, but in filing his price schedule with OPA he should make an accompanying statement to confirm that price. If his schedule merely shows a 3–12–6 premium brand, at $33.70, without any explanation, OPA will not be in position to readily ascertain whether the price is a legal one.

Similarly: Suppose (1) that a fertilizer manufacturer, during the period February 16–20, 1942, listed in his price schedule, at a certain premium, a premium brand of a grade that is not now an approved grade under FPO-5; and (2) that the manufacturer now claims the right to make a premium brand of a grade "similar" to the discontinued grade and to charge the same premium, and that he lists a premium brand of such similar grade at such premium. In filing his price schedule with OPA he should set forth the facts relied upon to confirm the premium. It is understood that under such conditions, the Office of

Price Administration, although not favoring an extension of premium pricing, will give consideration to approval of the premium.

October Sulphur Production

The current practice of filling the increased demand for sulphur from stock piles rather than from increased production was continued during October, according to the U. S. Bureau of Mines. Production during the month amounted to 199,135 long tons, while sales totaled 293,902 tons. Consequently producers' stocks on hand dropped from 4,657,000 tons at the end of September to 4,562,000 tons at the end of October. This is over 420,000 tons less than was in storage on October 31, 1942.

Long Island Cauliflower Fertilizer Experiments

Experiments conducted on Sassafras soils of Long Island, on which the bulk of the cauliflower crop is grown, show the minimum requirement to be 80 lb. nitrogen, 170 lb. phosphoric acid, and 40 lb. of potash. However, these are minimum requirements, and it has been the policy of the American Potash Institute to recommend somewhat higher rates. Their recommendation, therefore, would be 1800 to 2000 lb. of 5–10–5 or 4–10–5 per acre, the lower nitrogen being subsequently made up with a side-dressing of nitrogen. This fertilizer should contain borax unless the particular field has been well dressed with borax within the last 12 months; for fields treated with borax within the past three years, 5 to 10 lb. of borax, the lower amount on the heavier less-leached soils, the higher amount on the lighter well-drained sections. Sweet soils above pH 5.8 should be supplied the higher rates regardless of drainage.

U. S. D. A. Discusses Importance of Pasture Fertilization

U. S. D. A. Farmers' Bulletin 1942 entitled "Good Pastures" makes the following comments on liming and fertilization, "Pasture plants and light crop plants require the application of fertilizers when deficiencies exist in the soil. Such deficiencies may be the result of natural lack of fertility, continued removal of fertilizing elements in the forage consumed by livestock, with inadequate provision for the restoration of such elements to the soil. The problem is to recognize such deficiencies and to know what to apply and how much. The most common deficiencies in pasture soils can be corrected by applying lime and phosphate. On some soils, potash is also needed. It is usually best to apply enough at one time to meet the pasture needs for about 3 to 5 years. The applications most commonly recommended are one to two tons of ground limestone, 300 to 600 lb. of 20 per cent superphosphate, and 100 to 200 lb. of muriate of potash, or the equivalent in mixed fertilizers."

Extra Potash Pays on Tobacco

In a series of demonstrations on tobacco in South Carolina, 200 lb. of sulphate of potash applied as a side-dressing showed an average increase in value of $32.21 per acre over plots without extra potash, according to a report by H. A. McGee, Extension Tobacco Specialist. These results obtained from 789 demonstrations over a period of seven years covered 2,407 acres. About half of the acreage received from 36 to 60 lb. of potash per acre, and the other half 61 to 140 lb. The average yield was 1201 lb. per acre where the larger amount was applied, and 1080 lb. for the smaller amount —a difference of $30.85 in value per acre in favor of the higher application.

FERTILIZER MATERIALS MARKET

NEW YORK

Ammonium Sulphate Production Back to Normal. Still Dissatisfaction with Ammonium Nitrate Condition. All Potash Shipments Taken Eagerly. New Superphosphate Plants Planned.

Exclusive Correspondence to "The American Fertilizer"

NEW YORK, December 2, 1943.

Ammonium Sulphate

Production is coming back to normal and deliveries are being made in good quantity against allocations.

Ammonium Nitrate

With the increased quantity of this material becoming available, some difficulty may be experienced in disposing of the entire total. There is considerable difference of opinion regarding the condition of this material, with the majority of users seeming to feel that the use of ammonium nitrate is really a considerable hardship.

Nitrate of Soda

There is no change in the price of this material, and deliveries are being made regularly against previous allocations.

Potash

This material is being called for fully in line with previous allocations, and in many cases buyers are requesting rush shipments, proving the scarcity of same, as plants' stock piles have been fully depleted in most cases. There is some possibility that some foreign potash may arrive in this country, but there is no certainty of this so that foreign supplies cannot be counted upon.

Superphosphate

The last advices from Washington as to requirements of this material for 1944 are 8,000,000 tons. This total may be reached, provided all the anticipated new plants are in operation before the middle of the year, but with the scarcity of labor and materials, it is doubtful that new plants will be in production when expected.

BALTIMORE

Increase in Superphosphate Requirements Limited by Sulphuric Acid Available. Fish Products Scarce and Going to Feed Market Only.

Exclusive Correspondence to "The American Fertilizer"

BALTIMORE, November 30, 1943.

The most important matter of note during the past two weeks has been the report to the effect that the WFA has increased its estimate on superphosphate requirements for 1944 about forty per cent, but the greatest concern is over securing sufficient sulphuric acid to manufacture this increased quantity. Other than this, conditions are more or less routine.

Ammoniates.—The situation remains about the same with very little domestic tankage and blood available, and then at ceiling prices which are out of reach as far as fertilizer manufacturers are concerned. Offerings continue very few.

Castor Pomace.—While there were some sales made for November–December delivery at ceiling price of $2.90 ($3.52½ per unit N), f. o. b. producers' works, there are no further offerings on the market, and producers are not quoting for future delivery.

Sulphate of Ammonia.—It is reported that the production of this commodity is gradually getting back to normal, and shipments are still being made against allocated orders.

Nitrate of Soda.—The price on this remains unchanged for December, and the prevailing opinion seems to be that December allocations will be somewhat larger.

Superphosphate.—The market remains at ceiling price of 64 cents per unit and until such time as the Government releases an additional quantity of sulphuric acid, no appreciable increase in the manufacture of superphosphate can be looked for.

Fish Meal.—Offerings of fish scrap continue very scarce, fishing on the Chesapeake Bay

having stopped. Practically all sales are to the feed trade on account of the higher price obtainable from that source compared with fertilizer manufacturers.

Potash.—With shipments on Lend-Lease basis to Great Britain stopped, it is reported some improvement can be expected. Shipments to fill contracts are made as fast as produced.

Bone Meal.—There is no change in the market on this commodity, with offerings for fertilizer few and far between.

Bags.—No change in the situation since last report.

PHILADELPHIA

Activity in Fertilizer Market Slackens. Allocations Limit Amounts on Most Materials. Most Production Holding Up Well.

Exclusive Correspondence to "The American Fertilizer"

PHILADELPHIA, November 30, 1943.

Activity appears to have slackened off in the last couple of weeks. This might be due to the fact that raw materials are scarce, and perhaps there would be a bit more business in these items if they could be had. In addition, with many of the materials—organic and inorganic—under allocation and restrictions, possibly some mixers have obtained all they are permitted to acquire.

Ammoniates.—Most of the inorganic materials are under control by the Government, as is well known, so that the situation continues just about the same, as far as sales and purchases are concerned. The industry keeps an eye on production figures, probably hoping that these will rise sufficiently to permit increased allocations. As for organic ammoniates, these are still scarce, and even with the restrictions contained in FPO 12, revised, it is problematical whether any easing of the situation will be noted.

Sulphate of Ammonia.—While production took a light blow by the coal strike, the material has continued to be allocated on a 100 per cent basis.

Nitrate of Soda.—December price unchanged. Farmers are apparently taking delivery now for future application to crops.

Superphosphate.—The rate of production, from reports, seems to hold up well, but the demand continues great.

Bone Meals.—Inquiries for fertilizer mixing fail to turn up any worth-while quantities.

Potash.—Demand continues good, and users could probably take in more, if they were so permitted.

CHARLESTON

Organics for Fertilizers Extremely Scarce. Increase in Superphosphate Output Expected. No Cottonseed Meal Available.

Exclusive Correspondence to "The American Fertilizer"

CHARLESTON, November 29, 1943.

Nitrogenous.—There are still no additional offerings of processed tankage, and the fertilizer manufacturers are very much bothered as to where they are going to get the necessary supplies of organics.

Castor Pomace.—Sellers still refuse to quote any additional quantities.

Ammonium Nitrate.—This material has recently been moving freely.

Superphosphate.—The War Food Administration has increased the amount which they feel is necessary for 1944 to a total of 8,000,000 tons. While WPB is still trying to arrange the necessary shipments of sulphuric acid, nothing definite has yet been fixed.

Cottonseed Meal.—Referring to the recent order for the distribution of a limited amount of cottonseed meal for use in fertilizer, so far this has not been much help to the fertilizer manufacturers, as it has been impossible to find the meal.

CHICAGO

Organic Fertilizer Demand at Peak. Shortage of Labor and Materials Limit Supply. Feed Market Demand Strong.

Exclusive Correspondence to "The American Fertilizer"

CHICAGO, November 29, 1943.

The organic market in this territory has failed to register much change, with the demand for ingredients far in excess of supply. Trading can, therefore, be considered at a standstill.

Producers of nitrogenous maintain that shortage of raw material, and continued difficulty in obtaining labor prevent additional offerings for the present.

In the feed market, wet and dry rendered tankages and dried blood are in strong demand at full ceiling prices.

High grade ground fertilizer tankage, $3.85 to $4.00 ($4.68 to $4.86 per unit N) and 10 cents; standard grades crushed feeding tankage, $5.53 per unit ammonia ($6.72 per unit N); blood, $5.38 ($6.54 per unit N); dry rendered tankage, $1.21 per unit of protein, Chicago basis.

Delaware Alfalfa Fertilizer Recommendations

Delaware Mimeo Circular 25 entitled "Better Alfalfa for Delaware" outlines cultural and fertilizing practices essential for high-producing, long-lived stands of this crop. Farmers are advised to lime their more acid soils with about one ton of ground limestone, or its equivalent, per acre. In the preparation of the soil, from 400 to 500 lb. per acre of 20 per cent superphosphate should be plowed under. When the crop is seeded, from 300 to 500 lb. per acre of an 0–12–12 are recommended for heavy fertile soils, and a similar amount of a 2–12–6 for the lighter fertile soils. Annually thereafter, so long as the crop is producing satisfactorily, farmers are advised to top-dress each spring with from 500 to 600 lb. per acre of an 0–12–12 fertilizer. In addition to the above-mentioned minerals, which must be supplied by fertilization, many Delaware soils also require boron. A deficiency of this element shows up in alfalfa as severe yellowing of the leaves on the upper part of the plant, and sometimes causes the bud and tip of the plant to die. Boron deficiency can be corrected by from 15 to 20 lb. of borax per acre, applied separately with a cyclone seeder or mixed in the fertilizers which are used at planting time.

INCREASE IN PHOSPHATE ROCK CEILINGS

(Continued from page 11)

not more than 3 per cent moisture, no adjustment for excess grade or I. & A.

Ground 90 to 95 per cent minus 200 mesh or 80 to 85 per cent minus 300 mesh.

Grades

29 per cent P_2O_5	$4.65 per net ton basis 29 per cent P_2O_5 minimum.
30 per cent P_2O_5	$4.85 per net ton basis 30 per cent P_2O_5 minimum.
31 per cent P_2O_5	$4.95 per net ton basis 31 per cent P_2O_5 minimum.
32 per cent P_2O_5	$5.20 per net ton basis 32 per cent P_2O_5 minimum.
33 per cent P_2O_5	$5.70 per net ton basis 33 per cent P_2O_5 minimum.

No charge for car liners or car door boards.

Add 30 cents per net ton for bagging in valve bags which purchaser provides.

Add 30 cents per net ton for truck load shipments in bulk.

Add $1.50 per net ton for bagging in 100-pound multi-wall paper bags.

Car bulkheads—Add $2.00 per car for installing wooden bulkheads to separate bagged rock from unbagged rock only at buyer's request.

This amendment shall become effective December 3, 1943.

AXIS LOSES SICILY AND SULPHUR

(Continued from page 10)

probably been hard-pressed to meet essential needs for sulphuric acid.

Vast U. S. Output

Sulphur is obtained sometimes in volcanic regions, such as Sicily, or it may be found in non-volcanic areas, as in the United States. This country produces more than 3,000,000 tons annually, chiefly from two States, Texas and Louisiana. More than 600,000 tons of iron, copper, and zinc pyrites are also produced here each year, thus furnishing large additional quantities of free sulphur and sulphuric acid.

As in Europe, by far the largest share of the United States' production of sulphur is used in making chemicals, particularly sulphuric acid. Domestically, the most important customer for sulphuric acid is the fertilizer business, which is believed to consume approximately 25 per cent in peacetime. Chemicals and explosives are second, although the petroleum and iron-and-steel industries take amounts which the corresponding activities of the Axis could now ill afford to lose.

THE MAINTENANCE OF SOIL FERTILITY

(Continued from page 8)

the crop. On neutral soils phosphates may remain available for many years, but on acid soils in wet districts the phosphates rapidly go over to inert forms. Ploughed-out acid grassland is often so deficient in available phosphate that even cereals may fail, and yet too many farmers manure it in the same way as old arable land. They have not realized that the phrase "stored-up fertility" refers primarily to organic matter and nitrogen.

Potash is often the controlling factor for potatoes and other root and vegetable crops, and occasionally for cereals on very deficient soils.

Soils may be infertile, at least for certain crops, through deficiencies of a number of other elements. Thus, on some heath and light fensr eclaimed by liming, sugar beets, oats and potatoes may suffer from shortage of manganese. Other soils lack boron. Sometimes grass has insufficient cobalt to support healthy animals.

Occasionally soils are infertile through an excess of some toxic element, such as zinc. Animals may be more sensitive than crops. Thus excess molybdenum is responsible for the troublesome "teart" pastures of Somerset and excess selenium gives poisonous herbage in parts of South Dakota.

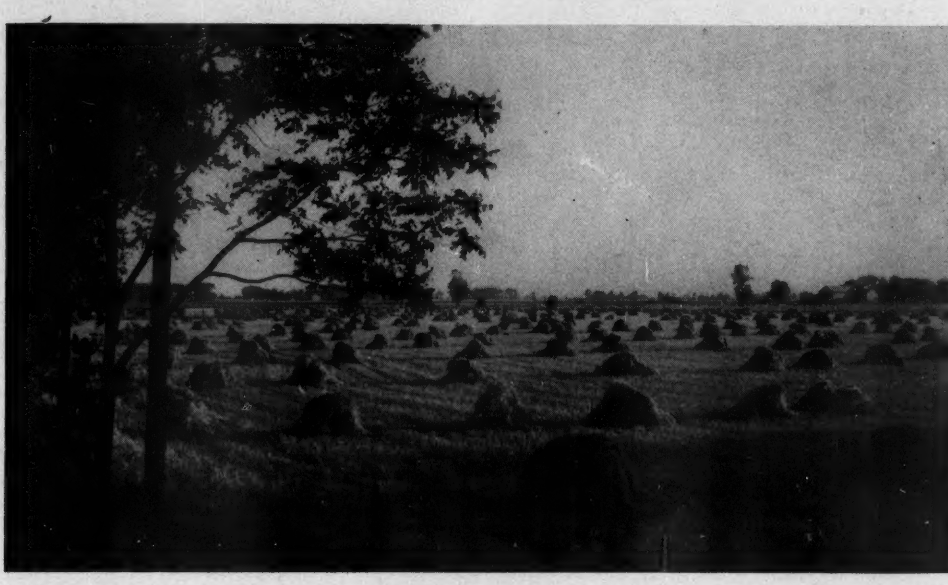
The chemical problems involved in recognizing nutrient deficiencies are complicated, and the methods of analysis are largely empirical. Their value will be greatly increased when they can be standardized by many more field experiments on the principal crops and soil series. Soil analyses are supplemented by methods of diagnosis based on leaf symptoms, plant analysis, and leaf injection.

The wide range of variation in readily soluble nutrients in farm soils is illustrated in Table I for fields selected as suitable for fertilizer trials on sugar beets. The table also shows how one method of soil analysis picks out the more responsive soils. Wartime ex-

TABLE I

SUGAR BEET EXPERIMENTS, 1933–1942

Soil Analysis by Citric Acid	Number of Experiments	Additional Sugar, cwts. per acre
P_2O_5, mgs. per 100g. (soils with less than 1.5% $CaCO_3$)		for superphosphate
to 8	5	5.5
8.1–16	34	2.6
16.1–24	38	1.2
24.1–32	31	1.1
32.1–48	27	1.3
Over 48	33	0.8
K_2O, mgs. per 100g.		for muriate of potash
to 4	11	5.1
4.1–6	40	4.6
6.1–8	56	4.3
10.1–12	62	2.2
12.1–16	23	1.2
16.1–24	22	—0.2
Over 24	6	—0.1



perience has shown that soils in the poorest groups are far more common than is indicated in Table I. In periods of depression farmers on these poorer soils use less and less fertilizer, and this in turn reduces the productivity of their land. On the other hand farmers who built up soil fertility by combining good farming with heavy manuring are apt to continue to use large amounts of phosphate and potash in the expectation that these will still be as effective as they were before the soil was well stocked with reserves. If fertilizers were distributed under the Rationing Scheme and used by farmers with closer reference to the needs of individual soils, the aggregate returns would be vastly increased.

Organic Manures

The continued debate on the value of organic manures in different systems of farming arises from the difficulty of analyzing the dominant factors in particular cases. In considering physical effects it is necessary to distinguish the coarse organic material still retaining its structure from the fully rotted colloidal material. Gross mechanical effects are important in opening up heavy soils, especially for potatoes and other root crops. For this purpose long manure and even straw may be applied early. Long manures may leave light land too open and well-rotted ones are therefore preferred at the cost of more loss of plant nutrients. Turf for greenhouse composts is needed mainly to enable the soil to take up water quickly, and it is likely that peat will be used increasingly for this purpose after the war. A novel suggestion from Dr. Bewley is to dig a vertical wall of straw into tomato beds on heavy soil in order that water may percolate through to the subsoil. In gardens composts may be used as mulches to protect the surface soil crumbs from beating rain and the force of water from a can or hose.

The well-rotted organic material enters into intimate association with the inorganic colloids and provides a large part of the soil's base exchange capacity, i. e., improves its power of holding potassium, calcium, magnesium in active and available forms. The organic colloids help to stabilize the soil crumbs and increase the capacity for air and water.

Discussions on the relative advantages of mixed and specialized farming systems are generally focused on the farmyard manure, but it is sometimes forgotten that in mixed farms the whole cropping program depends on the livestock kept and that much of the benefit to the soil is derived indirectly from the leys and root crops. Balance in farming might be more aptly expressed by the proportion of leys to tillage crops or by the rate at which the plough is taken round the farm, than by the amount of farmyard manure produced per acre of arable land. It is naturally far easier to keep a good balance with livestock, which allow the best use to be made of leys, of the by-products from arable crops and of land unfit for ploughing.

Under some old systems, such as the Norfolk rotation with bullocks fed in boxes, little but corn and meat was sold off the farm and the small amounts of plant nutrients so removed were nearly balanced by those in the purchased concentrates. Where large amounts of potatoes, vegetables and other crops are sold, the drain on the soil is increased and must be met by purchasing more fertilizers or animal feeding stuffs.

Before the war our farmers bought in imported feeding stuffs three times as much nitrogen as in fertilizers, as much phosphoric acid as in superphosphate and as much potash as in all potassic fertilizers. The actual figures are set out in Table II, which has been calculated from Dr. N. C. Wright's estimates of the total feeding stuffs for animals before the war. The principal items are for nutrients circulating between grazing animals and the top few inches of grassland. During the war the

arable acreage has been greatly expanded, more cash crops sold off the farms and imports of cereals and concentrates for animals drastically curtailed. Much larger quantities of nitrogenous and phosphatic fertilizers have therefore been required.

TABLE II

PLANT NUTRIENTS IN ANIMAL FEEDING STUFFS

(United Kingdom average, 1934–38)

	Thousand tons		
Home-produced:	N	P_2O_5	K_2O
Tillage crops	120	60	340
Hay	140	40	140
Grazing	400	120	460
Industrial by-products	17	12	2
Imported:			
Cereals and concentrates	210	110	70

PLANT NUTRIENTS IN FERTILIZERS

(Great Britain and Ireland, 1936)

	N	P_2O_5	K_2O
Total consumption	67	191	79

For many years to come we may have to be more nearly self-supporting in human food and animal feeding stuffs, and we must therefore continue to use more fertilizer. We have a long way to go before we approach the practice of some neighboring countries. If the pre-war consumption of fertilizers is expressed as plant nutrients per unit arable land, Holland used over five times, Belgium three times and Germany twice as much as Great Britain. In Holland a large amount of the fertilizer was, of course, used on grass. In Denmark, liquid manure furnished about twice as much nitrogen and four times as much potash as were used in fertilizers.

Under alternate husbandry our leys will be started with liberal supplies of phosphate and other plant foods, and in addition will utilize the residues from fertilizers given to the arable crops. The leys in turn will enrich the soil in organic matter and available nitrogen and build up its structure. Many new developments will be needed if livestock are to play their full part in this steady improvement of soil fertility. Water-supplies will have to be taken to remote fields and more use made of the Hosier bail system and temporary electric fencing.

Methods of dairy farming, especially on all-grass farms, will need reconsideration, as a case can be made against the dairy cow as a prime waster of soil fertility. Large amounts of nitrogen and potash from imported food-stuffs, hay and home-grown fodder crops, are lost down the drains, partly through the operation of Clean Milk Regulations and partly through the separation of cow-keeping from arable farming. The ploughing-up campaign has prevented some of the wastage by supplying straw with which to make farmyard manure or compost and also the arable land on which to use them. Even on mixed dairy farms the losses of plant nutrients are unduly high. Few of them have liquid manure tanks and very few indeed pumps and distributors in working order. This position may have arisen not merely from the difficulty of handling large volumes of liquid manure but from exaggerated ideas about the special values of solid manures and rotted straw. Here Danish experience is enlightening. As the results of research and practical experience Government subsidies have been transferred from covered dungsteads to liquid manure tanks. Almost all Danish farms now use liquid manure, and suitable distributors have been developed, including some in which it is applied below cultivator tines.

When straw is rotted down in farmyard manure, composts, or in the soil, it necessarily locks up available nitrogen to the extent of nearly one per cent by weight or the equivalent of about one cwt. of sulphate of ammonia per ton of straw. The rotted product resembles farmyard manure in appearance and physical properties, but as it contains only about two per cent of nitrogen in its organic matter, it liberates nitrogen slowly and often too late to benefit the immediately following crop. Richer manures supply more ammonia but are subject to great losses when exposed in small heaps or when spread on the field. The very rich manures from the old Norfolk bullock boxes provided ammonia at great cost, and far too much of it was lost.

At the present time there is little opportunity for producing wastefully rich manure, and a more common problem is to utilize surplus straw to advantage. Long manure applied early and followed by extra inorganic nitrogen to the next crop offers one solution.

If straw can be trampled or ploughed into

the ground in autumn, it may get most of the extra nitrogen needed for rotting from supplies in the soil, which might otherwise be washed out by winter rainfall. For market gardens or glasshouse conditions the straw can be rotted to compost by using sulphate of ammonia and limestone with any greenstuff or other organic waste available, but it is very doubtful whether an extensive use of sulphate of ammonia in this way would be justified on farms at the present time. A long-term Rothamsted experiment has shown that it is more profitable to apply the straw in autumn before potatoes and give the sulphate of ammonia directly to the crop than to use the sulphate of ammonia to make compost from the straw.

The position is quite different where straw can be rotted down by nitrogenous materials which might otherwise go to waste. Thus straw-composting provides an obvious means of saving liquid manure. It may also turn out that straw can be suitably composted with sewage sludge. The two materials have complementary properties. Straw is acutely deficient in nitrogen and phosphate but has some potash; sewage sludge, especially when it includes surplus activated sludge or when it has been digested, contains considerable amounts of nitrifiable nitrogen and available phosphate, but practically no potash. Both materials are difficult to apply to the land in their normal states. Sewage sludge alone is unlikely from its constitution to supply the more stable organic constituents, which are derived from the combination of lignin and protein and appear to be characteristic of humus. The rotting of straw and sewage sludge together, either in compost heaps or in the soil, may add to the humus supply and provide the three principal plant nutrients, if the necessary conditions can be worked out and the problems of transport and distribution overcome.

Before the war there was some prospect that town refuse might be made into a serviceable manure by suitable treatment, including removing the bulk of the glass and coal ash, but the success of the economy and salvage campaigns have necessarily taken away most of the ingredients on which its manurial value depended. It is unlikely that town refuse will now justify any appreciable expenditure of manpower and gasoline. The best course seems to be to use it to level out gravel pits and other irregular sites to remake land which can be cropped or converted into playing fields.

Gardens provide relatively larger amounts of waste plant material in greater variety than farms, and it is therefore much easier to make useful composts.

Summary

The general objectives in maintaining soil fertility may be summarized as follows:

1. Protect the surface soil from mechanical loss.
2. Make good the losses of organic matter, plant nutrients and soil structure, which are accelerated by cultivation.
3. Identify the principal controlling factors and correct them by drainage, liming, manuring, cultivation or grazing.

The vast variety of climates, soils, and farming systems with the constantly changing economic and social background, raise innumerable local problems in the application of these general principles. Many of these questions require scientific investigation and technical advice, but it is an overriding requirement that the farming community should be sufficiently keen and well-informed to know how to recognize its problems, where to turn for advice and how to resist the snares of doctrinaire propaganda. In the post-war agricultural policy for this country no step will do more to maintain the fertility of our soils than the provision of agricultural education on the scale envisaged by the Luxmoore Committee.

BUYERS' GUIDE • A CLASSIFIED INDEX TO ALL THE ADVERTISERS IN "THE AMERICAN FERTILIZER"

This list contains representative concerns in the Commercial Fertilizer Industry, including fertilizer manufacturers, machinery and equipment manufacturers, dealers in and manufacturers of commercial fertilizer materials and supplies, brokers, chemists, etc.
For Alphabetical List of Advertisers, see page 33.

ACID BRICK
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

ACID EGGS
Chemical Construction Corp., New York City.

ACIDULATING UNITS
Chemical Construction Corp., New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

AMMO-PHOS
American Cyanamid Co., New York City.

AMMONIA—Anhydrous
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.
Hydrocarbon Products Co., New York City.

AMMONIA LIQUOR
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.
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AMMONIA OXIDATION UNITS
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AMMONIUM NITRATE SOLUTIONS
Barrett Division, The, Allied Chemical & Dye Corp., New York City.

AUTOMATIC ELEVATOR TAKEUPS
Sackett & Sons Co., The A. J., Baltimore, Md.

BABBITT
Sackett & Sons Co., The A. J., Baltimore, Md.

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Bemis Bro. Bag Co., St. Louis, Mo.
St. Regis Paper Co., New York City.
Textile Bag Mfrs. Association, Chicago, Ill.
Union Bag & Paper Corporation, New York City.

BAGS—Cotton
Bemis Bro. Bag Co., St. Louis, Mo.
Textile Bag Mfrs. Association, Chicago, Ill.

BAGS—Paper
Bagpak, Inc., New York City
Bemis Bro. Bag Co., St. Louis, Mo.
St. Regis Paper Co., New York City.
Union Bag & Paper Corporation, New York City.

BAGS (Waterproof)—Manufacturers
Bemis Bro. Bag Co., St. Louis, Mo.
St. Regis Paper Co., New York City.
Textile Bag Mfrs. Association, Chicago, Ill,
Union Bag & Paper Corporation, New York City.

BAGS—Dealers and Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Wellmann, William E., Baltimore, Md.

BAG CLOSING MACHINES
Bagpak Inc., New York City.
St. Regis Paper Co., New York City.

BAGGING MACHINES—For Filling Sacks
Atlanta Utility Works, East Point, Ga.
Bagpak, Inc., New York City.
St. Regis Paper Co., New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

BAG PILERS
Link-Belt Company, Philadelphia, Chicago.

BEARINGS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

BELT LACING
Sackett & Sons Co., The A. J., Baltimore, Md.

BELTING—Chain
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

BELTING—Leather, Rubber, Canvas
Sackett & Sons Co., The A. J., Baltimore, Md.

BOILERS—Steam
Atlanta Utility Works, East Point, Ga.

BONE BLACK
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Huber & Company, New York City.

BONE PRODUCTS
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

BORAX AND BORIC ACID
American Potash and Chem. Corp., New York City
Pacific Coast Borax Co., New York City.

BROKERS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Dickerson Co., The, Philadelphia, Pa.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Keim, Samuel L., Philadelphia, Pa.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

BUCKETS—Elevator
Link-Belt Company, Philadelphia, Chicago
Sackett & Sons Co., The A. J., Baltimore, Md
Stedman's Foundry and Mach. Works, Aurora Ind

A Classified Index to Advertisers in "The American Fertilizer"

BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 33

BUCKETS—For Hoists, Cranes, etc., Clam Shell, Orange Peel, Drag Line, Special; Electrically Operated and Multi Power
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

BURNERS—Sulphur
Chemical Construction Corp., New York City.

BURNERS—Oil
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.

CABLEWAYS
Hayward Company, The, New York City.

CARBONATE OF AMMONIA
American Agricultural Chemical Co., New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.

CARS—For Moving Materials
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CARTS—Fertilizer, Standard and Roller Bearing
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

CASTINGS—Acid Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.

CASTINGS—Iron and Steel
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CEMENT—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

CHAIN DRIVES—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAINS AND SPROCKETS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAMBERS—Acid
Chemical Construction Corp., New York City
Fairlie, Andrew M., Atlanta, Ga.

CHEMICAL APPARATUS
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

CHEMICALS
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
Bradley & Baker, New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.
Huber & Company, New York City.

CHEMICALS—Continued
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Phosphate Mining Co., The, New York City.
Wellmann, William E., Baltimore, Md.

CHEMICAL PLANT CONSTRUCTION
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHEMISTS AND ASSAYERS
Gascoyne & Co., Baltimore, Md.
Shuey & Company, Inc., Savannah, Ga.
Stillwell & Gladding, New York City.
Wiley & Company, Baltimore, Md.

CLUTCHES
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CONCENTRATORS—Sulphuric Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CONDITIONERS AND FILLERS
American Limestone Co., Knoxville, Tenn.
Dickerson Co., The, Philadelphia, Pa.
Phosphate Mining Co., The, New York City.

CONTACT ACID PLANTS
Chemical Construction Corp., New York City

COPPER SULPHATE
Tennessee Corporation, Atlanta, Ga.

COTTONSEED PRODUCTS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

CRANES AND DERRICKS
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

CYANAMID
American Agricultural Chemical Co., New York City
American Cyanamid Co., New York City.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Jett, Joseph C., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

DENS—Superphosphate
Chemical Construction Corp., New York City.
Stedman's Foundry and Mach. Works, Aurora, Ind.

A Classified Index to Advertisers in "The American Fertilizer"

BUYERS' GUIDE

For an Alphabetical List of all the Advertisers. see page 33

DISINTEGRATORS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind

DRYERS—Direct Heat
Sackett & Sons Co., The A. J., Baltimore, Md.

DRIVES—Electric
Link-Belt Company, Philadelphia, Chicago

DUMP CARS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

DUST COLLECTING SYSTEMS
Sackett & Sons Co., The A. J., Baltimore, Md.

ELECTRIC MOTORS AND APPLIANCES
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

ELEVATORS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ELEVATORS AND CONVEYORS—Portable
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

ENGINEERS—Chemical and Industrial
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ENGINES—Steam
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

EXCAVATORS AND DREDGES—Drag Line and Cableway
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link Belt Speeder Corp., Chicago, Ill., and Cedar Rapids, Iowa.

FERTILIZER MANUFACTURERS
American Agricultural Chemical Co., New York City.
American Cyanamid Company, New York City.
Armour Fertilizer Works, Atlanta, Ga.
Farmers Fertilizer Company, Columbus, Ohio.
International Minerals and Chemical Corporation, Chicago. Ill.
Phosphate Mining Co., The, New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

FISH SCRAP AND OIL
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Wellmann, William E., Baltimore, Md.

FOUNDERS AND MACHINISTS
Atlanta Utility Works East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind

GARBAGE TANKAGE
Wellmann, William E., Baltimore, Md.

GEARS—Machine Moulded and Cut
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GEARS—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

GELATINE AND GLUE
American Agricultural Chemical Co., New York City.

GUANO
Baker & Bro., H. J., New York City.

HOISTS—Electric, Floor and Cage Operated, Portable
Hayward Company, The, New York City.

HOPPERS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

IMPORTERS, EXPORTERS
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

IRON SULPHATE
Tennessee Corporation, Atlanta, Ga.

INSECTICIDES
American Agricultural Chemical Co., New York City.

LACING—Belt
Sackett & Sons Co., The A. J., Baltimore, Md.

LIMESTONE
American Agricultural Chemical Co., New York City.
American Limestone Co., Knoxville, Tenn.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
McIver & Son, Alex. M., Charleston, S. C
Wellmann, William E., Baltimore, Md.

LOADERS—Car and Wagon, for Fertilizers
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Acid Making
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Duriron Co., Inc., The, Dayton, Ohio.
Fairlie, Andrew M., Atlanta, Ga.
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Coal and Ash Handling
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Elevating and Conveying
Atlanta Utility Works, East Point, Ga.
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Grinding and Pulverizing
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind

A Classified Index to Advertisers in "The American Fertilizer"

BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 13

MACHINERY—Power Transmission
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Pumping
Atlanta Utility Works, East Point, Ga.
Duriron Co., Inc., The, Dayton, Ohio.

MACHINERY—Tankage and Fish Scrap
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MAGNETS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MANGANESE SULPHATE
McIver & Son, Alex. M., Charleston, S. C.
Tennessee Corporation, Atlanta, Ga.

MIXERS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
Bradley & Baker, New York City.
Chilean Nitrate Sales Corp., New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

NITRATE OVENS AND APPARATUS
Chemical Construction Corp., New York City.

NITROGEN SOLUTIONS
Barrett Division, The, Allied Chemical & Dye Corp., New York City.

NITROGENOUS ORGANIC MATERIAL
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
DuPont de Nemours & Co., Wilmington, Del.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Smith-Rowland Co., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

NOZZLES—Spray
Monarch Mfg. Works, Philadelphia, Pa.

PACKING—For Acid Towers
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

PANS AND POTS
Stedman's Foundry and Mach. Works, Aurora, Ind.

PHOSPHATE MINING PLANTS
Chemical Construction Corp., New York City.

PHOSPHATE ROCK
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Coronet Phosphate Co., New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Phosphate Mining Co., The, New York City.
Ruhm, H. D., Mount Pleasant, Tenn.
Schmaltz, Jos. H., Chicago, Ill.
Southern Phosphate Corp., Baltimore, Md.
Virginia-Carolina Chemical Corp. (Mining Dept.), Richmond, Va.
Wellmann, William E., Baltimore, Md.

PIPE—Acid Resisting
Duriron Co., Inc., The, Dayton, Ohio.

PIPES—Chemical Stoneware
Chemical Construction Corp., New York City.

PIPES—Wooden
Stedman's Foundry and Mach. Works, Aurora, Ind.

PLANT CONSTRUCTION—Fertilizer and Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

POTASH SALTS—Manufacturers
American Potash and Chem. Corp., New York City.
Potash Co. of America, New York City.
International Minerals & Chemical Corp., Chicago, Ill.
United States Potash Co., New York City.

PULLEYS AND HANGERS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

PUMPS—Acid-Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PYRITES—Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., New York City.
Wellmann, William E., Baltimore, Md.

QUARTZ
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

RINGS—Sulphuric Acid Tower
Chemical Construction Corp., New York City.

ROUGH AMMONIATES
Bradley & Baker, New York City.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

A Classified Index to Advertisers in "The American Fertilizer"

BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 33

SCALES—Including Automatic Bagging
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SCRAPERS—Drag
Hayward Company, The, New York City.

SCREENS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SEPARATORS—Air
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Including Vibrating
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Magnetic
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHAFTING
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHOVELS—Power
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corporation, Chicago, Ill., and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

SPROCKET WHEELS (See Chains and Sprockets)

STACKS
Sackett & Sons Co., The A. J., Baltimore, Md.

SULPHATE OF AMMONIA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Hydrocarbon Products Co., New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

SULPHUR
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Freeport Sulphur Co., New York City.
Texas Gulf Sulphur Co., New York City.

SULPHURIC ACID
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M. Charleston, S. C.

SULPHURIC ACID—Continued
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
U. S. Phosphoric Products Division, Tennessee Corp, Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE—Concentrated
Armour Fertilizer Works, Atlanta, Ga.
International Minerals & Chemical Corporation, Chicago, Ill
Phosphate Mining Co., The, New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

SYPHONS—For Acid
Monarch Mfg. Works, Inc., Philadelphia, Pa.

TALLOW AND GREASE
American Agricultural Chemical Co., New York City.

TANKAGE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Smith-Rowland, Norfolk, Va.
Wellmann, William E., Baltimore, Md.

TANKAGE—Garbage
Huber & Company, New York City.

TANKS
Sackett & Sons, Co., The A. J., Baltimore, Md.

TILE—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

TOWERS—Acid and Absorption
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

UNLOADERS—Car and Boat
Hayward Company, The, New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

UREA
DuPont de Nemours & Co., E. I., Wilmington, Del.

UREA-AMMONIA LIQUOR
DuPont de Nemours & Co., E. I., Wilmington, Del.

VALVES—Acid-Resisting
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

WHEELBARROW (See Carts)

ZINC SULPHATE
Tennessee Corporation, Atlanta, Ga.

ALPHABETICAL LIST OF ADVERTISERS

For Classified Index, see pages 28 to 32, inclusive

EACH A RECORD BREAKER

BUT ONE HAS THE WINNING SPEED AND EFFICIENCY FOR YOU!

Today when time is so vital the three St. Regis Packaging Systems are doing their bit by shaving priceless manhours from the time once required to package an infinite variety of products. Because each of these systems sets new records on the job for which it was specifically designed, St. Regis has no favorite system. Following an on-the-spot survey of your packaging operation, we recommend *the* system best suited to *your* product—and *your* production needs.

The many industries changing over to Multiwall Paper Bags welcome the added protection given their products—and the savings in manpower and money effected by St. Regis Packaging Systems. These savings can be yours, too, if your product is baggable in rugged, custom-built Multiwalls, and is packed in 25 to 100 lb. units.

VALVE PACK — ***Maximum Production and Minimum Labor*** are outstanding features of the St. Regis Valve Pack System. Your product is preweighed by St. Regis Automatic Packing Machines (Belt, Screw or Impeller type) and rapidly propelled into valve type, self closing Multiwall Paper Bags. Gravity Type Packers are available for free-flowing products.

SEWN PACK — ***Rapid, Uniformly Siftproof Closures*** are assured open mouth bag users with the St. Regis Sewn Pack System. Automatic sewing machines apply a bound-over tape and filter cord, and quickly sew through all plies of the bag. Powdered products cannot work their way through this extra strong closure.

TIED PACK — ***Greater Economy on Moderate Production*** is achieved with the St. Regis Wire Tied Pack System. A hand twisting tool constitutes the entire equipment for effecting the securely tied closure around the neck of the bag.

Our experience in solving the packaging problems of varying industries may be of great practical help to you. A St. Regis Packing Engineer will be happy to specify the type of bag required for your product—and recommend the packaging system best suited to your production needs.

St. Regis Bags are built of 3 to 6 independent walls of specification kraft paper fabricated in tube form, one within the other, so each bears its share of the load. Chemical and physical properties of product determine number and weight of kraft and special sheets.

MULTIPLY PROTECTION • MULTIPLY SALEABILITY

ST. REGIS PAPER COMPANY

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CHICAGO: 230 No. Michigan Avenue

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Vancouver, B. C.

Baltimore, Md. · Kansas City, Mo. · Franklin, Va. · Birmingham, Ala. · Los Angeles, Calif. · Nazareth, Pa. · Dallas, Tex. · New Orleans, La · San Francisco, Calif. · Denver, Colo. · Seattle, Wash. · Toledo, Ohio